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THESIS

**KNOWLEDGE VALUE ADDED AS A METHODOLOGY TO
EVALUATE THE OFFICE OF FORCE TRANSFORMATION'S
WOLF-PAC / STILETTO PROGRAM CONCEPTS**

by

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September 2006

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CONCEPTS

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ABSTRACT

With the DoD acquisition of programs and projects becoming increasingly expensive, it is imperative that the method or measure for determining value for a particular project, real or conceptual, be identified and used enterprise-wide. The form of analysis known as the Knowledge Value Added (KVA) methodology, KVA will evaluate the Office Force Transformation Wolf-PAC / Stiletto concepts. This thesis will explore two distinctly different areas which demonstrate the KVA method's use and benefit:

1. The use of the KVA method to find improvements in a Command and Control (C2) process, and
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LIST OF ACRONYMS

ALT	Actual Learning Time
COA	Course of Action
C2	Command and Control
DoD	Department of Defense
DoN	Department of the Navy
IT	Information Technology
KVA	Knowledge Value Added
MHC	Coastal Mine Hunter
NT	Nominal Time
OJT	On The Job Training
OPSO	Operations Officer
ROK	Return on Knowledge
ROKI	Return on Knowledge Investment
ROI	Return on Investment
SME	Subject Matter Experts
TLT	Total Learn Time
UAV	Unmanned Aerial Vehicle
UUV	Unmanned Undersea Vehicle

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I. INTRODUCTION

A. PURPOSE/PROBLEM STATEMENT

With the introduction of the strategic document "Forward from Sea," it has been the United States Navy's plan to create a sea-based combat force that can be seamlessly integrated into joint and combined military operations. To accomplish this goal the Department of the Navy (DoN) spends millions of dollars each year on operational research, developmental programs, operational platforms and systems. However, it is tremendously difficult to assess these developmental programs and operational systems, which are designed to maximize the flexible and unique combat capabilities in the joint warfighting force of today. This assessment process is however important and should emphasize the full value as well as cost of warfare capabilities.

There are several quantitative and qualitative indicators that are used to evaluate operational activities. Private sector businesses emphasize marketplace results over output indicators. This runs contrary to the approach espoused by the Department of Defense (DoD). Much of the difference in approach can be explained by a difference in orientation; the profit-oriented private sector uses net profit as the metric of choice. Therefore, many of the indicators used by the private sector corporations can not be used effectively by the DoD because DoD entities do not measure profit.

About one third of the DoN funding is spent on programs to develop and acquire new capabilities or

modernize existing capabilities.¹ But without a scalable benefit such as profit, it is hard to determine what methodology should be used to measure the benefit or performance of Navy seabased operational innovations. Unlike the private business sector, the DoD has been unable to find a suitable methodology to reflect the true return on investment (ROI) of its operational programs, platforms or systems because they have no proper surrogate for revenue. The DoD should continue to explore new ways to quantify the benefits of operational innovations in new or existing DoD programs, systems, and platforms in order to impose the discipline of the market. For example, Adam Smith's "Invisible Hand" description conveys the motivations behind the free market.

The system in which the invisible hand is most often assumed to work is the free market. Adam Smith assumed that consumers choose for the lowest price, and that entrepreneurs choose for the highest rate of profit. He asserted that by thus making their excess or insufficient demand known through market prices, consumers "directed" entrepreneurs' investment money to the most profitable industry.²

B. COMMAND AND CONTROL

In general terms within the DoD, "Command and Control (C2) is considered the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission."³ C2

1 Department of the Navy Policy Paper. "...From the Sea" Update, The OpNav Assessment Process, May 1993, p. 3
<<http://www.chino.navy.mil/navpalib/policy/fromsea/ftpsuoap.txt>>
(accessed July 14, 2006).

2 Plus Magazine, issue 14, Adam Smith and the Invisible hand, Helen Joyce, March 14, 2006. <<http://plus.maths.org/issue14/features/smith/>>
(accessed August 5, 2006).

3 Defense Technical Information Center. DoD Dictionary of Military and Associated Terms. Joint Publication 1-02.

functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. Understanding C2 can not be considered an option, but should be regarded as a requirement in the face of 21st century challenges. As technology increases in this information age, our approaches to C2 within the military should provide significantly increased capabilities and adapt to the challenges in this information age. In recent years the Navy has addressed the need to recognize and focus upon the new opportunities to improve C2. The DoN's commitment is outlined in the "Naval Transformation Roadmap 2003, Assured Access & Power Projection...From the Sea." The document explains that in this information age "advances in technology provide the opportunity to move the functionality provided by platforms to the info structure, the sensors, or the actor, thus permitting us to decouple functions from traditional platforms when necessary."⁴

Currently, the DoD's Office of Force Transformation (OFT) has initiated the operational program known as Wolf PAC. The program's primary goal is to examine the Command and Control (C2) operations as they pertain to geographically dispersed, networked, autonomous and semi-autonomous assets. This program was initiated because of the DoD's increased focus on meeting both the challenges of Information Age Warfare, as well as those caused by the large size and dispersed assets of DoD defense forces

⁴ D. Alberts, J. Garska, and F. Stein, "Network Centric Warfare: Developing and Leveraging Information Superiority." National Defense University Press, 1999.

during operations. "Today, Forces are increasingly burdened by the lack of a coherent strategy to "control" large numbers of dispersed assets. Distributing those assets geographically, loosely federated by networks, only serves to increase complexity."⁵ To address this and other C2 issues, a major objective of the Wolf PAC operation will be to conduct operational experiments that examine C2 challenges of distributed networked forces in joint Sea Based and Special Operations missions. Ultimately, creating a shared awareness of elements distributed and employed across the battlespace will give decision makers and warfighters a tremendous advantage in operational tempo.

The OFT has stated that its intent is to increase experimental transaction rates generating higher learning rates that enable the DoD to quickly produce investment options that adapt to an uncertain future. These investment options can only be correctly decided upon if the proper ROI can be determined from the Wolf PAC's conceptual and operational approaches for improving the C2 development process.

C. WOLF PAC STILETTO SHIP PLATFORM

One of several Wolf PAC operational assets is the Stiletto ship, a high-speed, carbon reinforced fiber craft vessel. It is one of the major assets and the main undertaking of the Wolf PAC program. The OFT believes that in order to win future littoral combat operations it will require a diverse variety of assets, networked and distributed as a joint force. It also believes the

⁵ Department of Defense, Office of Force Transformation, Wolf PAC Transforming Defense, Distributed Adaptive Operations, p. 1.

Stiletto platform will meet the needs of this requirement. The OFT defines the Stiletto's value and purpose to be:

Stiletto represents one of the many assets to be used for distributed operations, purposely designed to investigate the underlying rules for success and survival in complex environments such as the littoral. *Stiletto* is designed to explore the scalability of non-mechanical dynamic lift, composite construction technology, high-speed performance and its application to military operations. *Stiletto* and craft like her are not meant to replace or compete with capital ships of the line; instead they are intended to have capital potential in every hull.⁶

Additionally, some of the Stiletto's capabilities include littoral operations such as mine counter measures, direct support of Special Operation Forces, launch and retrieve an ILM-Rigid Inflatable Boat, as well as launch and operate unmanned vehicles to include Unmanned Aerial Vehicles (UAV) from the upper deck. All of the capabilities can be considered combat multipliers. However, since the Stiletto does not compete with other capital ships but does demonstrate its capital potential in every hull, there should be an accurate measure of what the additional value or potential of this platform provides to the Navy.

D. RESEARCH OBJECTIVES

The objective of this research is to analyze the potential benefits for investing in the Wolf PAC operational C2 concept and the operational asset the Stiletto ship could provide to the U.S. Navy in littoral operations using a Knowledge Value-Added methodology. Currently, within the DoD there is not a defensibly

⁶ Department of Defense, Office of Force Transformation, Wolf PAC Transforming Defense, Distributed Adaptive Operations, p. 5.

objective methodology to determine ROI. The models will assist in assessing the efficiency of Wolf PAC operational C2 concept and its operational surrogate, the Stiletto platform, in terms of process capacity and productivity. This analysis will apply an ROI methodology capable of demonstrating these advantages in common units of monetization of value measurements, (i.e., allowing, revenue, as well as cost).

Development of these models will help to determine output measures that can be monetized using the market comparable approach. Because the methodology used will be an analytical approach, it will provide decision-makers additional comparable information by which to judge and compare existing operational processes or systems associated with the Wolf PAC. The results of this application of methodology may be applied to this and similar DoD programs, thus enabling decision makers to make more disciplined program acquisition and budget decisions.

E. METHODOLOGY

This thesis will attempt to model the current Command and Control process, as it applies to the Wolf PAC operations to produce an improved model which incorporates information technologies that support distributive operations. This thesis will also attempt to model several of Stiletto ship operational capabilities and make comparisons to the current model of the Navy's existing littoral operations capable platform such as Coastal Mine Hunter (MHC), in order to determine the increased value of the Stiletto ship over the existing Navy ships. The

Knowledge Value-Added (KVA) methodology will be utilized to measure the impact that improved processes and technologies will have on the current process.

The analysis will include identification of all major processes, sub-processes, inputs, and respective outputs. Additionally, the analysis will define all cost and value data related to each asset in the process, both human and information technology (IT) driven. Analyzing the sub-process for the models will include the surrogate value measure, time-to-learn, number of personnel involved and the number of times each process is executed. Subject Matter Experts (SMEs) will be interviewed to validate that the processes, persons involved and execution times are accurate. Market comparable values will be used to help estimate the revenue surrogates that will in turn help to monetize value in the methodology. The time to learn, also known as the knowledge embedded in each sub-process, will be multiplied by the number of executions of those sub-processes. The resulting figures will be used as a basis for the KVA approach for allocating revenue at the sub-process level. The end result is a ROI performance ratio. This resulting value may be used by decision makers as an acceptable method to examine values of a future operational activity, program, or system.

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II. LITERATURE REVIEW

A. LITTORAL WARFARE

Seventy-five percent of the world's population lives within 100 miles of a coastline. The United States Navy's mission for Littoral Warfare is to maintain a dominant presence within those coastal regions which are of strategic importance. To do this, the Office of Force Transformation (OFT) developed an initiative called Wolf Pac/Stiletto to provide command and control (C2) as well as provide shallow water operations within the region. Wolf PAC will explore emerging concept-technology pairings to develop near term solutions to coordinate with coherence large numbers of geographically dispersed, networked assets.

B. MINING CHALLENGES

Mines located in the shallow and very shallow⁷ water of the littoral environment have the same effect on the movement of vessels that a minefield has on forces ashore: they slow the movement and channel the forces into killing zones.⁸ Mines can impede the safe execution of U.S. Naval activities and constrain the ability of the United States to pursue the nation's interests.

Mines are pervasive, cheap, and do not require a sophisticated military force to employ them. The breakup of the former Soviet Union and their need for hard currency

⁷ In mine warfare terminology the term "very shallow water," or VSW, refers to those mines located from the outer edge of the surf zone to the two and one half fathom curve, or 21 feet. The term "shallow water" refers to those mines located between 21 and 25 feet in depth.

⁸ Kenneth M. Kobell, Lieutenant Colonel, USMCR, "Putting America's 911 Force on Hold," U.S. Naval Institute Proceedings, September, 1995, p. 73.

could easily lead to even wider export of mines.⁹ The ship primarily used for mine hunting has always been the MHC Osprey class ship. The ability to tackle mine hunting operations has increased the littoral capabilities with the new development of the Stiletto platform.

C. OPERATIONAL SURVIVAL

In order to survive and win in future littoral operations it will require a diverse variety of assets amalgamated as a networked, distributed joint force. It demands a force that shares information widely and takes advantage of pattern ambiguity, readily consumes increased information volume and can adapt to ever increasing complex conditions. Scale-matched assets are critical to the architectural structure of Wolf PAC.

Stiletto represents one of the many assets to be used for distributed operations, purposely designed to investigate the underlying rules for success and survival in complex environments such as the littoral. The Stiletto ship is a composite - fiber, high-speed vessel, designed to explore the scalability of non-mechanical dynamic lift, composite construction technology, high-speed performance and its application to military operations.

⁹ Larry K. Brown, Major, USMC, "Mine Countermeasures and Amphibious Operations a Line in the Sea," June 20, 1991, p. 6.

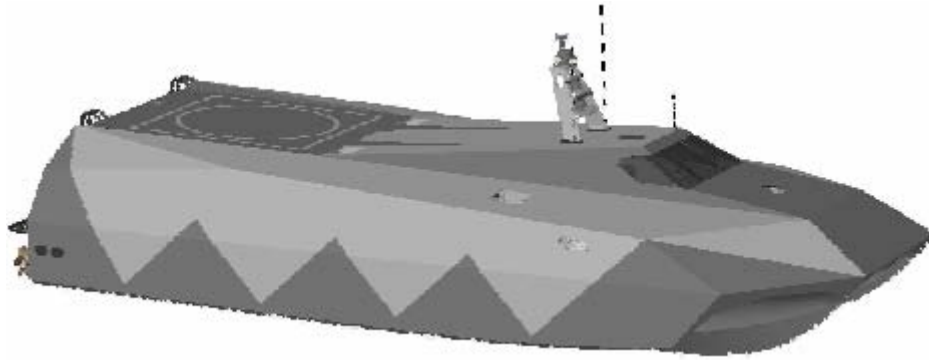


Figure 1. Stiletto.¹⁰

Stiletto's specific characteristics incorporate modularity at multiple levels and use an electronic keel (data bus) for rapid mission reconfiguration which provides the necessary flexibility for SOF-like forces to deploy, modify and tailor capabilities to emerging challenges. Stiletto also explores high payload fractions capable of shallow water operations for speed of deployment and access to unprepared and contested zones. Stiletto's main purpose is to accommodate, launch and retrieve an 11m-RIB as well as launch and operate unmanned vehicles to Unmanned Aerial Vehicles (UAV) from the upper deck. Stiletto will also represent one of the many nodes within the Wolf PAC experiment providing circulatory system needs regulated by the demand centered neural network of *Sense and Respond Logistics*.¹¹

¹⁰ Technical Exploration Operational Experimentation Industrial expansion, Stiletto / Wolf PAC.
<http://www.oft.osd.mil/library/library_files/document_398_Wolfpac%20holler%20plan.pdf> (accessed August 28, 2006).

¹¹ Sense and Respond Logistics (S&RL) is an OFT initiative that seeks to transform how the defense departments sustains geographically dispersed and distributed adaptive forces.

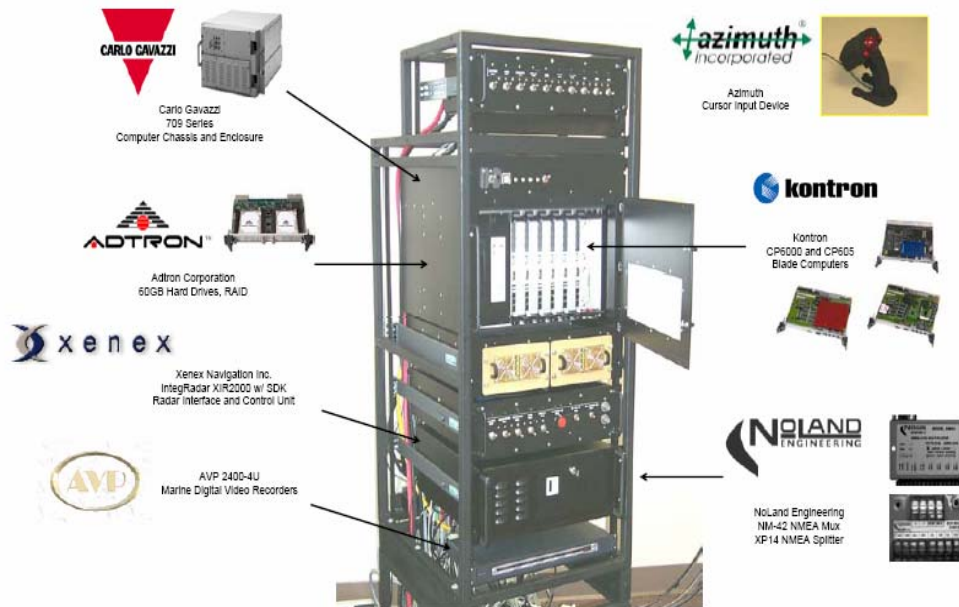


Figure 2. Electronic Keel.¹²

D. WOLF PAC OPERATION

Wolf PAC will explore emerging concept-technology pairings to develop near term solutions to coordinate with coherent large numbers of geographically dispersed networked assets. Wolf PAC has four key objectives:

1. Create Options

- i. Acting on NCW principles of war, produce physical and virtual surrogates that allocate joint networked capabilities
- ii. Preserve design teams and intellectual talent to create a stable commercial market
- iii. Loosen requirements - foster incentives for innovation by setting broad objectives
- iv. Increase variety and numbers
- v. Broaden the technology base

2. Increase Transaction Rates

- i. Provide a venue for developing operational experience through immersion
- ii. Establish high numbers of operational experiments with imperfect surrogates

¹² Wolf PAC,
<http://www.oft.osd.mil/initiatives/stiletto/docs/Wolf%20PAC%20Components%20and%20Participants.pdf> (accessed August 28, 2006).

- iii. Create new knowledge and tacit understanding of complex problems

3. **Ensure Higher Rates of Learning**

- i. Produce high numbers of co-evolutionary cycles to solve for complex problems
- ii. Iterate organizational relationships that dynamically adapt to context mission dependent and scale relevant challenges
- iii. Observe, understand and influence behaviors at the scale that events occur

4. **Create Overmatching Complexity**

- i. Engineer for collective behavior and design toward networked effects
- ii. Understand connection topologies and connection strengths
- iii. Increase diversity at the right scale
- iv. Synchronize high numbers of networked capabilities

E. **THE APPROACH**

Wolf PAC will describe, develop, and explore measurable design rules & metrics

a. ***Design Principles for Distributed Operations and Distributed Networked Forces***¹³

- ***Recombination***: ability to aggregate, distribute or interchange physical, informational or logical elements and connections
- ***Dispersion***: avoid spatial, informational, or logical centers of gravity thereby confounding adversarial C2 and scouting resources
- ***Mobility***: sufficient speed for rapid relocation of elements and reconfiguration of elemental collectives (physical or logical means)
- ***Pattern masking & ambiguity***: envelope management performance. Greater numbers of elements provide physically smaller elements and the ability to hide among the clutter

¹³ Jeffrey R. Cares, Raymond Christian and Robert Manke, Fundamentals of Distributed, Networked Forces and the Engineering of Distributed Systems, NUWC-NPT Technical Report 11,366, May 9, 2002.

- **Proximity:** uncouple physical component's direct proximity to threat (effect of mass without the massing of forces or elements)
- **Flexibility:** principles of modularity - Fluid system substructures with range of modular interoperability options - measure of adaptively
- **Persistence:** ability to operate w/o disruption of cyclic logistics and operations

b. Investigate Networked Behavior of Large Numbers of Geographically Dispersed Assets

- **Speed of response:** Diffusion rates, Number of Nodes
- **Speed of command:** Average path length, neutrality
- **Self-synchronization:** Path Horizon, Auto-catalytic Sets
- **Shared awareness:** Clustering distribution, organizational relationships, between-ness

c. Deliverables

- Technical Model - evaluate - validate - modify simulation tools & evolutionary algorithms to emulate complex environments.
 - Determine network relationships between surrogates
 - Establish standards, protocols, and interfaces for surrogates
- Operational
 - CONOPS for distributed adaptive operations - how many in what variety & combination using NCW conceptual framework. Determine how to employ, deploy, sustain, and C2 a distributed, networked force
 - Applied engineering solutions to coordinate with coherence (C2) Wolf PAC

F. KVA AND THE USE OF IT

KVA provides a means to measure the amount of knowledge with an organization, in equivalent units and that are required to produce the outputs of an organization.

There four assumptions that allow KVA to compare units of change within organizations:

1. Humans and technology in organizations take inputs and change them into outputs through core processes.
2. All outputs can be described in terms of the amount of change (i.e., complexity) required to produce them.
3. All outputs can be described in terms of the time required by an "average" learner to learn how to produce them. Learning time can be considered a surrogate for the amount of organizational knowledge required to produce the outputs. KVA describes these common units of learning time (i.e., units of output) by using the term knowledge units.
4. A knowledge unit is proportional to a unit of complexity, which is proportional to a unit of change.¹⁴

G. PROBLEM-SOLVING CONTRIBUTIONS OF KVA TO REAL OPTIONS ANALYSIS

There are four phases in which real options occur over time:

- Phase One - The structure of the problem is established
- Phase Two - The options of the Plan and Frame are laid out
- Phase Three - The option is implemented over time
- Phase Four - Track options results and adjust decision paths

¹⁴ Jonathan Mun, Real Options Analysis, pp. 573-574.

The Phase One in the KVA problem-solving can make significant contributions by providing a higher quality of fundamental data inputs to the structure of the problem. Real options analyses are currently using project-level, or even company-level, data for real options analysis. Currently there no specific organizational data that can be used. KVA is a tool that can analyze the effects of core processes on a project and provide raw data on estimated organizational revenues and costs.

In addition, KVA can make major impact in Phase Four. As KVA data is collected, it can be used to assemble near real-time option performance assessments.

III. THE KNOWLEDGE VALUE ADDED METHODOLOGY

A. ISSUE OF VALUE

Within the Department of Defense (DoD) defining value or determining return on investment (ROI) for specific DoD program/project or major end-item procurement has remained a difficult and inexact science. In contrast to the DoD, the profit oriented business sector can readily define value or ROI. In measurable business oriented terms, value is defined when one product bests another in delivering greater value to a business sector. This usually occurs either when one product efficiently reduces the firm's costs in some aspect of its operations, when it enhances the firm's revenues, or when it achieves some combination of the two. Such valuable products improve a firm's bottom line and ultimately determine how "value" is defined to the business institution and its customers.

Additionally, ROI, which is a performance measurement, is used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments; ROI is calculated as the benefit (return) of an investment divided by the cost of the investment; the result is expressed as a percentage or a ratio.

$$ROI = \frac{(\text{Gain from Investment} - \text{Cost of Investment})}{\text{Cost of Investment}}$$

It is the metric of choice by the majority of business sector because of its usability, versatility and simplicity. However, because there is no goal of creating profit or gain in dollars within the DoD, there is no

definable method to quantify or qualify the determination of value or return in investment for many DoD programs/projects.

Determination of value lends itself to metrics associated with monetary assessment. For example, in the private sector a price per unit assignment can be assigned to outputs, whereas, this can not be done within the DoD because of the non-profit orientation of its process outputs. Determining value contributions from programs/projects in a monetary sense to increase operational readiness or increase combat effectiveness can not be done. To resolve this problem, a common unit to be used in the value determination of DoD program/projects output, that can be used in both operational and financial analysis and decision making is an important factor in resolving the problem.

B. KNOWLEDGE VALUE SOLUTION

The Knowledge Value-Added (KVA) methodology was developed by Dr. Thomas Housel (Naval Postgraduate School) and Dr. Valery Kanevsky (Agilent Lab). Its purpose was to help guide business process re-engineering efforts of organizations. KVA methodology was designed to assist in determining the value in an organization's core processes, employees, or IT investments, instead of merely focusing on cutting costs. The KVA methodology takes these core processes and knowledge assets of an organization and provides a methodology for allocating revenue and cost to these assets based on the amount of change each produces.¹⁵

¹⁵ T. Housel and A. Bell, Measuring and Managing Knowledge. Boston: McGraw-Hill 2001. p. 92.

The methodology then determines the value or benefit by assessing the cost of each sub-process or knowledge asset relative to its overall contribution.

1. KVA Theory

The basic theory behind KVA methodology was based upon a description of all process outputs in similar units. One assumes that the purpose of a business is to produce value by way of its processes, thereby transforming inputs into suitable outputs. The theory was derived from the concepts of complexity and entropy.¹⁶

The changes organizational processes make in the structure of inputs to outputs can be described in a common way. The concept of entropy is defined as a measurement of the degree of disorder--or amount of the change in a system. In the context of business processes it can be used as a surrogate for the amount of changes that a process makes to inputs to produce attendant outputs. These process-induced changes can be measured in terms of the equivalent corresponding changes in entropy.

KVA is considered a framework for measuring the value of organizational knowledge assets. This framework which is rooted in the knowledge economy provides organizations a way to equate a common metric such as price and cost, to the amount of knowledge in known core processes and assets. The results of a KVA analysis are known as Return on Knowledge (ROK). ROK is, therefore, the resulting ratio between the price and cost for these determined common units of knowledge. Ultimately, ROK supplies necessary information relating to the value or measure of benefit.

¹⁶ T. Housel and O. El Sawy, Model for Measuring the Return on Information Technology: A Proof of Concept Demonstration, Presentation 2001. p. 11.

2. KVA Assumptions

This application of a KVA framework has wider implications in that it may be aptly used within the context of organizational processes. The framework is based on an operating premise that procedural knowledge used to produce outputs for a process may also be viewed as a surrogate of process outputs. These processes with predetermined outputs may be described in terms of the amount of time it takes the average learner to understand how to produce those outputs.¹⁷

Housel et al. fully describes this process in their demonstration for ICIS 2001:

At a given point in time, a company's total process outputs produce its revenue. It follows, that the procedural knowledge required to produce those outputs is a surrogate for the revenue. Further, if this procedural knowledge, which is distributed among people and IT, can be described in common units, then it is possible to allocate corporate revenue to these units of knowledge. This would allow establishment of a common price per unit of procedural knowledge. It follows that price per unit of procedural knowledge is a surrogate for price per unit of common output. This formulation allows a direct linkage between corporate revenue and the procedural knowledge distributed among the people and IT used to produce the revenue.¹⁸

The figure below depicts the fundamental assumptions of KVA. It is the underlying model which explains that change, knowledge, and value are proportionate.

¹⁷ T. Housel and O. El Sawy, p. 14.

¹⁸ Ibid.

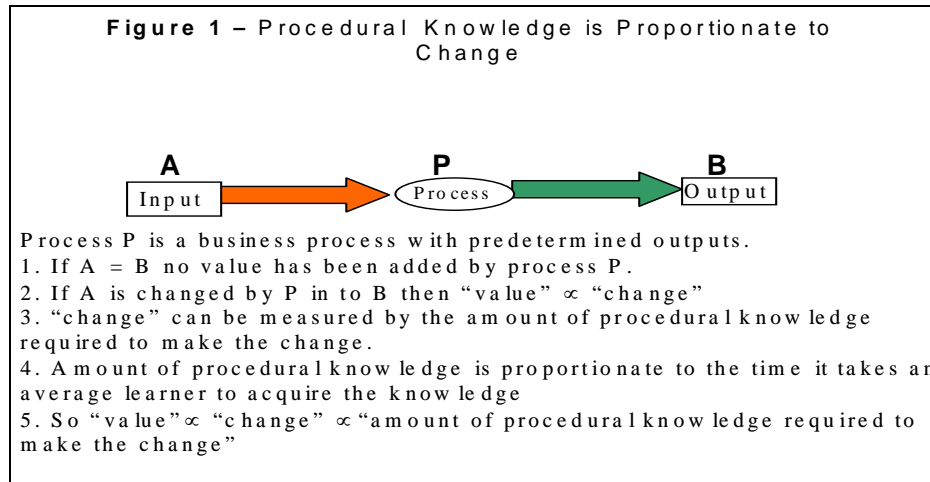


Figure 3. The Housel/Kanevsky Value-Added Cycle.¹⁹

As noted the KVA theory offers a way to describe all process outputs in equivalent units. This becomes advantageous for several reasons:

- The ability to compare all processes in terms of their relative productivity
- The ability to allocate revenue to a common unit of output
- The ability to describe the value added by IT in terms of the outputs it produces
- The ability to relate outputs to the cost to produce those outputs in common units
- A common unit of measure for organizational productivity²⁰

An organizations ability to decompose inputs into common units of outputs allows processes to be assessed from the same common baseline reference. It also allows for revenue and cost to be assigned to these processes. At the point that valuation of processes can be directly associated with a financial metrics, KVA results can be used in a similar manner to other profitability metrics.

¹⁹ Housel and Bell, 2001.

²⁰ Housel, et al., December 2001, p. 11.

3. Approaches to KVA

Learning Time Approach	Process Description Approach	Binary Query Method
Identify compound process and its component processes.	Identify compound process and its component processes.	Identify compound process and its component processes.
Establish common units to measure learning time.	Describe the products in terms of the instructions required to reproduce them and select unit of process description	Create a set of binary YES/NO questions such that all possible outputs are represented as a sequence of YES/NO answers.
Calculate learning time to execute each component process.	Calculate number of process description words, pages in manual, lines of computer code pertaining to each process.	Calculate length of sequence of YES/NO answers for each component processes.
Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.	Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.	Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.
Multiply the learning time for each component process by the number of times the component executes during sample period.	Multiply the number of process words used to describe each component process by the number of times the component executes during sample period.	Multiply the length of the YES/NO string for each component process by the number of times this component executes during sample period.
Allocate revenue to component processes in proportion to the quantities generated by previous step.	Allocate revenue to component processes in proportion to the quantities generated by previous step.	Allocate revenue to component processes in proportion to the quantities generated by previous step.
Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component process.	Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component process.	Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component process.

Table 1. Approaches to KVA.²¹

²¹ David Walsh, "Knowledge Value Added: Assessing both Fixed and Value." Business Process Audits.Com. White Papers. Business Process Audits.Com, 13 August 1998.
<<http://www.businessprosaudits.com/kvawalsh.com>> [06June2005] (accessed August 10, 2006).

a. Learning Time

In the learning time approach the amount of knowledge is measure based on the time it would take an average individual to learn how to complete the process correctly. The measurements should be in common units of time (i.e., hours, days, and weeks) and should be verifiably reliable. Generally SME's, will provide actual estimates of the learning time required for a given process based on formal and informal training times, to include experience on the job, training manuals, distance education and any other source of training that would be relevant to the generation of an output by means of the process indicated. KVA makes possible the initial estimate for allocating revenue or sales dollars to the various core processes. The goal of KVA is to establish relative orders of magnitude for the amount of knowledge embedded in core processes.²²

b. Process Description

This approach measures the number of instructions needed to reproduce the outputs produced. Using the process description approach enables the KVA methodology to achieve a higher level of detail in the process description than does the learning time approach. It requires a more detailed and analytical description of each process and the amount of instructions needed to produce each output. The process instructions are calibrated in terms of their complexity.²³

c. Binary Query Method

This approach creates a set of binary yes or no questions such that all possible outputs are represented as

²² Housel and Bell, 2001.

²³ Ibid.

sequences of yes or no answers, which are equated to bits. The sequences of answers are determined and value is attributed to the outcome that is produced.²⁴

C. RETURN ON KNOWLEDGE (ROK)

Return on Knowledge (ROK) is ratio which represented by a numerator that depicts revenue allocated to an amount of knowledge required to complete a given process successfully, in proportion to the total amount of knowledge required to generate the total outputs. The denominator of the ratio is the cost to execute the knowledge within the process.²⁵ In this process knowledge is considered a surrogate for common units of outputs. This ROK ratio identifies the value added within process provided by the knowledge assets. Understanding the results of ROK can provide decision makers with valuable information and insight into core processes of project or program. ROK can provide a productivity measure for current knowledge assets and depict how effective and efficient knowledge assets may be when applied throughout different areas within a process. Using KVA methods ROK can be an indicator for ROI. The analytical way ROK value is determined makes it invaluable to both profit oriented and non-profit oriented organizations like the DoD.

²⁴ Housel and Bell, 2001.

²⁵ Web ProForum Tutorials., Knowledge Value Added (KVA) Methodology.
<<http://www.ieg.org>>, (accessed June 15, 2006).

IV. PROOF OF CONCEPT

The OFT has several major initiatives that pertain to exploration of C2 operational concepts. For the purpose of this thesis, the proof of concept is focused on two areas. Part I assesses the impact of the Wolf PAC operation upon DoD C2 processes. Part II assesses the value of one of the major initiatives of the OFT, Wolf PAC Stiletto ship mine hunting operations. The reason this thesis uses the KVA methodology in two case concepts is to demonstrate that the KVA methodology is not one dimensional in its use. Though the process remains the same, KVA can be utilized for various types of assessments or valuations. In Part I KVA will be used to demonstrate its ability to improve a current process. In Part II of this thesis an assessment of a current Navy ship's operational standard will be evaluated in comparison to a new prototype ship and its new operational standard process.

A. PART I: A C2 (CONCEPTUAL MODEL)

The Wolf PAC operation, as previously noted, is a group of operational experiments designed to explore C2 operational concepts of geographically dispersed, networked, autonomous and semi-autonomous assets. In order for the OFT to genuinely explore C2 concepts, there should be some method of evaluating current C2 structured processes. The research questions posed in this thesis are essentially threefold: (1) what is the current state of the DOD's C2 structure, (2) how is it evaluated, and (3) if changes are made for the improvement of the process, how is the improvement measured.

One major experiment, known as Stiletto, is a combat craft initiative designed to benefit from densely networked

sensor technologies, tactical space assets, unmanned vehicles, and new hull forms which take advantage of modularity, speed, and complexity to increase lethality and survivability.

1. Objective

The objective of this portion of the research is to evaluate a conceptual model of the C2 process, utilize this model to assess the value of identifying areas in which the C2 processes can be made more efficient and effective. The expectations are twofold: (1) to produce a new C2 perspective based on current concepts and (2) generate ideas for operational C2 to be evaluated using a common value metric based on the KVA methodology. This methodology was chosen because it is capable of producing an objective measure and is based on easily defined criteria. Once processes are defined and baseline measures are created the overall "as-is" process data can be compared to the additions or changes within the existing processes. The resulting comparisons can then be made to current, "as-is" scenario based on the "to-be" scenario, and the "radical to-be" scenarios. These comparisons can be used to evaluate the C2 process structures and possible process changes to the C2 operational process.

2. Data Collection Methodology

It is recognized that some form of the C2 process happens at almost every level of command and that commands and the higher echelons tend to use a more formal and detailed process approach to C2. However, there is no DoD standard or formal structure process for C2 on which this study could be modeled. Therefore, for the purposes of evaluating C2 for this thesis, a conceptual C2 model was developed. The underlying assumptions were that the model

created would represent a similar methodology or framework currently in use for the C2 operations of military organizations.

Understanding that a process needed to be defined, the research team chose Colonel John Boyd's "Observe, Orient, Decide, Act (OODA) Loop"²⁶ model to represent the current process for conducting C2 operations. The OODA loop performs several functions within the C2 domain. It defines boundaries, translates ideas and observations into action, shows the process as cyclical in nature, and facilitates the conceptual outline of the C2 process. It has significant limitations, however, with respect to providing an explanation of the activities within the defined boundaries.

Combined with the Marine Corps Planning Process (MCPPE), Boyd's OODA loop is used to create a conceptual C2 model. "The Marine Corps Planning Process is an internal planning process used by Marine Corps operating forces. It aligns with and complements the joint deliberate and crisis action planning processes found in Joint Pub 5-0, *Doctrine for Planning Joint Operations*."²⁷

The processes, steps, and products associated with the MCPPE were used as inputs and outputs, or sub-processes, to the major steps within the OODA loop. Based on discussions with SMEs, the research team developed this conceptual process as a viable representation of the current operational C2 model. An examination of the newly developed "as-is" or existing processes shows that in order

²⁶ OODA Loop is defined.

²⁷ Department of the Navy, Marine Corps Planning Process. Marine Corps Logistics Base, Albany, GA. pp. 1-2.

to improve the current C2 process, there should be a departure from the traditional structure based on centralized control and limited information sharing. A successful approach requires a C2 concept that decentralizes control through improved collaborative information sharing and shared situational awareness. Ultimately, this will lead to forces that are self-synchronized.

3. Modeling a C2 Process

For this thesis the C2 process is represented by the OODA process. It is understood the OODA process was one that is cyclical in nature. However, in order to use the KVA analysis accurately, the flowchart representing the C2 process had to be depicted as a linear process. This would represent one cycle through the OODA loop representing the C2 process. Again, the process flowchart was developed, using OODA as the process with the inputs and outputs represented by the some of the major tenets of the Marine Joint Planning Process deliverables as depicted in Figure 4.

AS IS FLOW CHART FOR COMMAND AND CONTROL

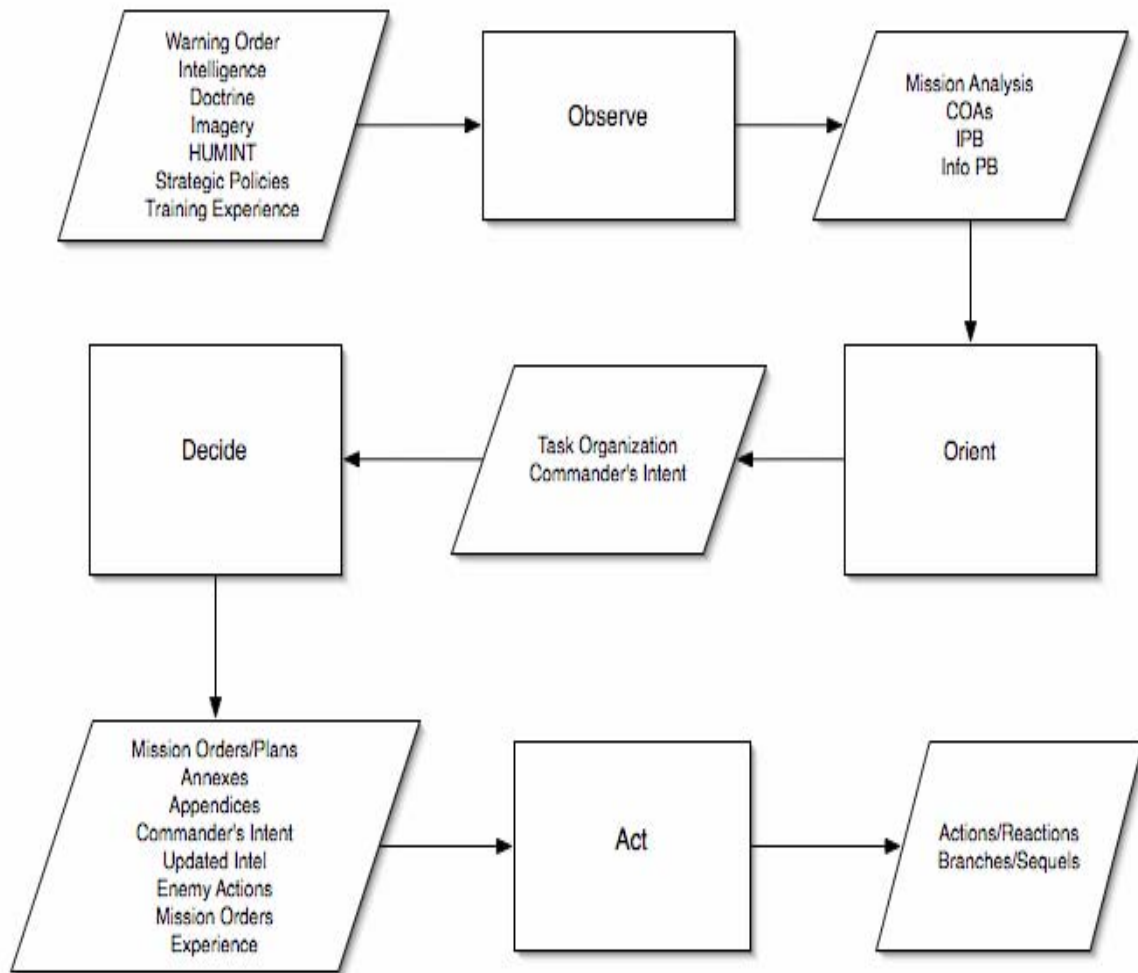


Figure 4. As-Is Flowchart.

The process as it is shown represents the conceptual outline of the C2 process for this thesis. Within this C2 loop are the processes that utilize actionable sub-processes to be evaluated. The following is a brief description of the generalized process for this model:

Sub-Process Name	Sub-Process Description
Mission Analysis	<p>Review and analyze orders, guidance, and other information that is provided by higher headquarters in order.</p> <p>To produce a unit mission statement.</p>
Course of Action Developments	<p>Process is designed to generate options for follow-on wargaming and comparison that satisfy the mission, commander's intent, and guidance of the commander.</p>
Course of Action Wargaming	<p>Allows the staff and subordinate commanders to gain a common understanding of friendly-and possible enemy-courses of action.</p>
IPB/Info PB	<p>Intelligence preparation of the battlespace enables planners to view the battlespace in terms of the threat and the environment.</p> <p>It helps planners determine how the enemy will react to proposed friendly COA.</p>
COA Selection	<p>The commander evaluates all friendly courses of action against established criteria, evaluates them against each other, and selects the course of action that he believes will best accomplish the mission.</p>
Commander's Intent	<p>The commander's personal expression of the purpose of the operation. It should be clear and concise. The purpose of providing intent is to allow subordinates to exercise judgment and initiative—to depart from the plan when the unforeseen occurs—in a way that is consistent with the higher commander's aims.</p>
Integrated Planning	<p>A disciplined approach to</p>

Sub-Process Name	Sub-Process Description
	planning that is systematic, coordinated, and thorough.
Mission Orders Development	During mission order development commander's COA decision, mission statement, and commander's intent and guidance to develop orders that direct unit actions. Orders serve as the principal means by which the commander expresses his decision, intent, and guidance.
Transition	Transition is an orderly handover of a plan or order as it is passed to those tasked with execution of the operation.
Act/Execute	Carrying out plan or orders of the commander's intent.

Table 2. Sub-Process Description.

The major assumptions associated with the purpose of this chain of core processes are:

- It should support the commander/decision-makers in making decisions in a time constrained and uncertain environment
- It should direct and coordinate actions
- It should develop a shared situational awareness
- It should generate expectations about how actions will evolve and then affect the desired outcome.
- It supports the exercise initiative

Ultimately, with this conceptual C2 model the processes should allow the decision-maker the ability, per the OODA loop, to observe, orient, decide, and act effectively in the midst of uncertainty. Ultimately this provides an effective way of achieving a desired end state.²⁸

²⁸ Department of the Navy, Marine Corps Planning Process. Marine Corps Logistics Base, Albany, GA, p. 7.

4. Assumptions and Data

The following assumptions as they apply to the conceptual c2 model, KVA proof of concept.

a. Length of C2 Process

For this model the cycle period is 72 hours. For this reason, some annual cost data is adjusted to reflect this time period.

b. Cost Assumptions

Cost of active duty military personnel was derived from annual DoD military personnel salary for Fiscal Year 2006 as presented on the Defense Finance and Accounting Service.²⁹

OPT total costs per hour based on yearly salaries		
Personnel	Rank	Yearly Salaries
1	0-7	\$121,000.00
7	0-6	\$99,000.00
7	0-5	\$82,000.00
8	0-4	\$70,000.00
4	0-3	\$55,000.00
27		\$2,168,000.00
Average cost per hour		\$30.88

Table 3. OPT Total Costs Per Hour.

c. Surrogate Revenue Assumptions

Surrogate revenues are based on a market comparable approach which attempts to identify business sector profit-oriented organizations which produce

²⁹ Defense finance and Accounting Service. "Basic Pay" <http://www.dod.mil/dfas/militarypay/newinformation/WebPayTableVersion2006updated.pdf> [01 January 2006] (accessed August 22, 2006).

comparable outputs to the particular DoD non-profit organization or entity. This approach assumes if outputs are similar, the particular business sector's processes to generate the outputs are comparable to the DoD organizations processes to obtain outputs. Also, this approach assumes that profit oriented private sector organizations have placed a monetary value to the comparable outputs yielding a revenue stream for the commercial entity and monetary value can be applied to the DoD organization. This monetary value can then be used to create pseudo revenue for the DoD organization. For this research, the following business organization was used to derive market comparable values.

Since 1970, Kennedy Information has been the leading source for competitive intelligence and market analysis on Management and IT consulting services. They provide strategic support and custom research to buyers and sellers of management consulting and IT services. Leveraging over 30 years of knowledge in the consulting profession and proprietary databases as a foundation, Kennedy Information offers unparalleled industry expertise and hands-on experience to help providers and buyers of consulting services maximize the value of their relationships.³⁰

Kennedy Information Consultant Fee		
Personal	Salary Per Hour	Position
1	\$341.00	Partner
7	\$287.00	Project Leaders
9	\$231.00	Senior Consultant
5	\$192.00	Consultant

³⁰ Association of Executive search Consultants.
<http://www.aesc.org/article/sokennedy/?PHPSESSID=04f685718020c93a700ef775bd6c92c5> (accessed August 6, 2006).

Kennedy Information Consultant Fee		
Personal	Salary Per Hour	Position
5	\$147.00	Analysis
Total	27	\$6,124.00
\$227.00 Consultant Fee / hour is multiplied by total man-hours to generate equivalent revenue		

Table 4. Consultant Fee.

d. Other Assumptions

IT Learning Time. It was assumed that the knowledge embedded in information technology (IT) systems can be derived by averaging the time it would take an average learner to learn how to produce the same outputs produced by the IT system in a single sub-process output cycle. The following assumptions will be applied in the analysis listed in Table 5.

Year=	52 Weeks	260 days		
Week=	5 Days	50 hours		
Nominal Learning time total = 52 weeks				2600 hours

Table 5. Assumptions.

5. "As Is" KVA Analysis

An analysis of each sub-process within this C2 process is provided in Table 5. The core processes listed have been defined by the SME's who were either trained in the Joint Planning Process/Marine Corps Planning Process or were operationally utilized or those who participated in this process. Each category for the KVA analysis is defined below:

a. Number of Iterations of Process in Each Cycle

The number of iterations of process in each cycle represents the number of times each sub-process is executed by the specified staff. In this process the specific sub-process may have multiple occurrences at different points within the overall process.

b. Number of People Involved

The "Number of People Involved" category represents the number of personnel which are involved in the specific sub-process. Personnel are assigned to staff sections. The number of participating personnel from each staff section is based upon SME estimates, noting there is no standard.

c. Staff Justification for People Involved

This category identifies the individuals, staffs or staff members that are involved in a specific sub-process.

d. Percentage of IT

This is a representation of the extent to which automation is utilized in the sub-process. IT is measured on a scale from zero percent to 100 percent. Estimating the IT involvement accurately ensures that knowledge which is embedded in the IT resources is accounted for within sub-processes. Also the IT column identifies how information technology is used to complete the process, such as a word processing program, communication programs, or other software designed and implemented for the purposes of enabling C2 management. The degree of automation in the sub-process is considered the amount of outputs that are completed by IT resources.

e. Ordinal Ranking

The ordinal ranking of the sub-processes was assigned by the SME who ranked the sub-processes based on complexity to learn each process. Lower numbers equate to less complexity while larger numbers depict more complexity. The complexity of the processes is also indicated by the surrogate learning time (SLT) column where the most complex tasks are presumed to take longer to learn. This ranking is completed independently of SLT estimates. In order to demonstrate the reliability of the ranking estimates, a correlation is derived mathematically between ordinal ranking and SLT. A high correlation percentage between these columns is an indication that the estimates are accurate when compared to the complexity of the sub-processes and the time it takes to learn them (SLT).

f. Time to Complete

For this modeled process, seventy-two hours is the total time it takes to complete this process (also the time needed to complete the sub-processes).

g. Surrogate Learning Time (SLT)

The SLT is derived from the relative size of the kilo-bytes (KB) of the information manuals or classes for each sub-process as listed by the Marine Corps Staff Training class website. Each kilo-byte is a surrogate for learning time and complexity in the KVA analysis. The correlation between these columns in this process is approximately 70% which is an indication that the estimates are accurate when compared to the complexity of the sub processes and the time it takes to learn them based on the relative size of the information manuals or classes.

h. Total Knowledge (K)

Total knowledge represents the amount of knowledge embedded in the sub-process. It is determined by multiplying the number of personnel involved in the sub-process, the number iterations of the sub-process, and the SLT. This result is divided by the percentage of IT category, (1-IT %).

i. Surrogate-Revenue Numerator

This surrogate-revenue is the amount of revenue allocated based on the percentage of the amount of knowledge embedded in each stage in terms of total knowledge. "It can be represented as a percentage of the revenue or sales dollar allocated to the amount of knowledge required to obtain the outputs of a given process in proportion to the total amount of knowledge required to generate the corporation's salable outputs."³¹ Total pseudo-revenue was calculated by multiplying the average consultant fee (\$227 per hour) by the number of consultants (27) by the number of hours (72) to complete the cycle through the C2 process. The Pseudo-Revenue, or numerator, is derived by multiplying the allocation factor by the total Pseudo-Revenue for each sub-process.

j. Total Cost Denominator

The denominator represents the costs that are used to generate the outputs or expenses of the process. The cost in this case, or denominator, is derived from the time it takes to complete a sub-process task, multiplied by the number of people involved per the sub-process, multiplied by the average cost per hour for completing the

³¹ Housel and Bell, 2001.

work. Military base pay for selected pay grade across staff section was used in order to compute the average cost per hour for this analysis.

k. Return-on-Knowledge

Return on Knowledge (ROK) is the ratio between the surrogate revenue numerator and the total cost denominator. This ratio allows for comparison of expenses and revenues associated with the embedded knowledge assets. This ROK will be used to compare efficiency in performance within a sub-process and assist in determination of relative value throughout the entire process.

1. "As-Is" Data Analysis

The format shown in Table 6 displays the core process subdivided into sub-processes in order to evaluate each sub-process and provide a method to examine its relative value. This was done by placing focus on the ROK ratios that were produced. The "As-Is" analysis provides a measure of the knowledge assets within the process.

[illegible]

Table 6. KVA "As-Is" Spreadsheet.

The initial focuses for improvement of the C2 process were those areas that had the lowest ROK. The ROK is a relative comparison between the total revenue and total costs columns. The ROK percentage depicts the value or benefits over costs ratio for each sub-process. The numbers in the ROK column can be used as the origin for determining which sub-processes are providing the least amount of value in the overall conceptual C2 process. Low ROK percentages represented low ROK and added lower values to the overall C2 process. It was decided to concentrate on these sub processes and allocate the resources to one of the following functions: deleting them, merging them, increasing IT usage, increasing the number of iterations, or increasing their value by making them more efficient (decreases time to complete).

The resulting "as-is" analysis provides the ability to create viable solutions for the improvement of the current C2 process by assigning measurable value to sub-processes.

m. "To-Be" KVA Analysis

The "To-be" is notional representation of possible results given changes to the existing "As-is" sub-processes. Two strategies to change or improve the current "As-is" process were introduced. Not all sub-processes would be affected in the "To-be" modeling and should be assumed as static. These solutions would attempt to improve the ROK percentage in the areas that were originally noted as low ROK. The solutions would also improve the ROK% in other sub-processes as well. These solutions are the "to-be" and "radical to-be", respectively. The "to-be" is designed to be an easier solution to implement because of

the low complexity and few changes to the process. This solution provides noticeable improvement in the ROK percentage to the process without much difficulty or disruption to the overall designed C2 process.

The additional solution mentioned the "radical" would involve major changes to the designed C2 process. The "radical" improvements produce even higher ROK percentage for the sub-processes. However, in order to achieve these higher ROK percentages, more significant changes had to be made to the designed C2 process. Such significant changes may be more difficult and may cause more disruption to the overall designed C2 process than that of the "to-be" process. The "to-be", "radical" and the "radical (2)" KVA flowcharts and spreadsheets are discussed in further detail.

Noted changes made in the "To-Be" model are shaded in the Table 7 shown below. ROK comparisons with previous "As-Is" shown at the right side of the table.

Subprocesses	Number of Iterations of Process in Each Cycle	# People Involved (Per Unit)	Staff Justifications for People Involved	Percentage of IT	Ordinal Ranking of SubProcesses	Time to Complete (hours)	SLT(KB)	SLT(%)	Total Knowledge	Allocation Factor	Pseudo-Revenue Numerator	Total Cost Denominator	TO BE ROK (Revenue / Expense)	AS IS ROK (Revenue / Expense)
Mission Analysis	2	27	Everyone	33.00%	6	4	1304	8.32%	105098.51	15.41%	\$86,603.73	\$992.67	872%	872%
COA Development	3	27	Everyone		3	4	1232	7.86%	99792.00	14.63%	\$82,231.04	\$992.67	828%	828%
COA Wargaming	1	27	Everyone		4	4	1172	7.47%	31644.00	4.64%	\$26,075.43	\$992.67	263%	263%
IPB/info PB	1	7	G2 section	40.00%	8	12	1709	10.90%	19936.33	2.92%	\$16,429.67	\$772.08	213%	213%
COA Selection	1	7	CG + Primary Staff		1	3	837	5.34%	5859.00	0.86%	\$4,827.96	\$193.02	250%	250%
Command Intent	2	3	CG, CoS, G3		3	1	569	3.63%	3414.00	0.50%	\$2,813.22	\$27.57	1020%	1020%
Integrated Planning	3	27	Everyone	33.00%	9	19	1709	10.90%	20610.45	30.29%	\$170,252.04	\$4,715.20	361%	163%
Mission Orders Development	3	9	G3 Section	20.00%	7	6	1112	7.09%	37530.00	5.50%	\$30,925.63	\$486.34	623%	623%
Transition	1	27	Everyone	33.00%	2	6	703	4.48%	28329.85	4.15%	\$23,344.49	\$1,489.01	157%	105%
Act	1	27	Everyone		10	13	5332	34.01%	143964.00	21.10%	\$118,629.84	\$3,226.19	368%	266%
70.25%	correlation between SLT and Ordinal ranking					72	15679	100.00%	682180.14		\$562,133.04	\$13,887.44	404%	317%
	< 80% because of the large SLT for "ACT"													

Table 7. To-Be Spreadsheet.

Changes made to the "to-be" KVA spreadsheet were targeted towards those areas deemed to have a low ROK percentage. Those changed sub-processes were Integrated Planning, Transition, and Act. The integrated planning cycle iterations were increased from one to three in order to increase situational awareness within the process. Next, an adjustment was made to the time to complete the sub-process by transferring four hours from the Act sub-process to Integrated Planning sub-process. Additionally, we added IT usage to the Transition sub-process. IT usage in the transitional process would include increased use of IT management and dissemination tools such as the use of wireless technologies like personal data assistants (PDA's), or web-castings, in order to rapidly transmit information to those that need it. These changes made to the core process are to achieve the goal of an improved C2 process model with improved shared information awareness, and the objective of self-synchronization within the forces of the organization. The results of these changes produced noticeable increases in the Pseudo-Revenue totals and the ROK percentage for the targeted sub-processes.

n. "Radical To-Be" Analysis

The "Radical To-be" model is a notional representation of possible results given changes to both the existing "As-is" and "To-be" sub-processes. Noted changes made in the "To-Be" model are shaded in Table 8 shown below. ROK comparisons with previous "As-Is" shown at the right side of the table.

As mentioned earlier the "Radical" process is one that involves major changes to the designed C2 process model. The major change in the "Radical" C2 approach is the elimination of the two sub-processes, COA Development and COA Selection. We are able to eliminate these sub-processes because of the addition collaborative IT tools such as planning templates, MCP's and decision support templates. This elimination also reduces the total cycle time of the C2 process from 72 hours to 62 hours. The eliminated COA development sub-process SLT was then added to the Integrated Planning sub-process SLT. Also, the eliminated COA selection sub-process SLT was then added to the COA Wargaming sub-process SLT. Other notable changes include the increase usage in IT percentages in the sub-processes and the changes in the iterations per cycle (i.e., # of times fired). These changes had a significant effect and resulted in an increased Pseudo-Revenue and ROK percentage. These changes coupled with the previous "To-Be" modeled changes may assist in the achievement of the goal to improved C2, with self-synchronized forces, by evaluating the sub-process in a defined and measurable manner.

o. Comparative Analysis

Table 9 is a comparative analysis chart which displays resulting ROK results for all three KVA assessments; "As-Is", "To-Be" and "Radical", respectively. As described earlier the changes within the sub-processes for the both the "To-Be" and the "Radical" increased the total ROK for the sub-processes overall. However, it is noted that in the "Radical" model there are several sub-processes, while having ROK results that exceed the "As-Is" model ROK results by significant margins, they were sub-

processes which had smaller ROK in some cases than the "To-Be" ROK results as shown in Table 9. This is explained by the major adjustment in the "Radical" model in which both the COA development and COA selection sub-processes were eliminated. The elimination of these sub-processes, created a redistribution of the percentage of knowledge in each sub-process compared to total knowledge in the overall process, shown as the Allocation factor in each KVA table. This negatively impacted several sub-processes of "Radical" model, resulting in lower ROK results. However, the elimination of these sub-processes produced increased efficiency by reducing the cycle time of the overall process by seven hours over both the "As-Is" and "To-Be" models, while retaining an increased ROK over the "As-Is" model.

Sub-processes	As IS ROK (Revenue/Expense)	To BE ROK (Revenue/Expense)	Radical ROK (Revenue/Expense)
Mission Analysis	872%	872%	775%
COA Development	828%	828%	Process eliminated
COA Wargaming	263%	263%	597%
IPB/Info PB	213%	213%	187%
COA Selection	250%	250%	Process eliminated
Command Intent	1020%	1020%	605%
Integrated Planning	163%	361%	368%

Sub-processes	As IS ROK (Revenue/Expense)	To BE ROK (Revenue/Expense)	Radical ROK (Revenue/Expense)
Mission Orders Development	623%	623%	709%
Transition	105%	157%	139%
Act	266%	368%	327%
Total	317%	404%	382%

Table 9. Comparative Analysis.

p. Other Considerations

The KVA analysis is made difficult in this scenario because there is not a formally structured C2 process that can be modeled, therefore, all models will be different. However, no matter the structure, KVA analysis still can be used if the process can be defined in the processes described. This KVA analysis for this process provided a different way to effectively and efficiently find weakness in a process that would normally be difficult to pinpoint without using this type of analysis. In a process where there was not a defined method of evaluation, using KVA methodology gave the ability to use a common unit of measurement to assess and compare the value of process improvement by defining the amount of knowledge in the processes.

B. PART II: WOLF PAC, STILETTO SHIP OPERATION

The OFT explores and nurtures developing technologies that have not been identified as requirements by DoD. Its goal is to produce change within the DoD forces through operational experimentation. One of its major experiments is the Wolf PAC operational surrogate, the M80 Stiletto ship. The Stiletto is a combat craft initiative designed to benefit from densely networked sensor technologies,

tactical space assets, unmanned vehicles, and new hull forms which take advantage of modularity, speed, and complexity to increase lethality and survivability. Stiletto's first operational experiment was a mine hunting/mine clearance scenario in conjunction with San Diego's Naval Special Clearance Team One based out of Naval Amphibious Base, Coronado. This complex experiment demonstrated Stiletto's ability to support the mine clearance personnel as well as seven unique unmanned vehicles used to support their mine hunting/mine clearance mission. Additionally, the Stiletto "demonstrates the use of surrogates in the experimentation process to rapidly acquire, deploy, and employ new capabilities in today's uncertain security environment. It represents a new business model which revalues design principles for information age operations."³²

However, because of the experimental nature of this OFT research and development (R&D) program, it is difficult for the DoD to determine if this program is a proper investment option worth risking millions of dollars for R&D and possibly procurement. One of the basic principles of the OFT stresses the importance of developing and getting the correct metrics and applying them enterprise wide.³³ Ultimately for OFT new concept program, the Stiletto, DoD should be able to establish metrics to form a baseline that can compare and access the employment of the Stiletto's operational capabilities. This may assist in enabling the

³² Department of Defense, Office of Force Transformation, Wolf PAC Transformation, Wolf PAC Transforming Defense, Distributed Adaptive Operations, p. 5.

³³ Department of Defense, Office of Force Transformation, <http://www.oft.osd.mil/library/library_files/document_297_MT_StrategyDoc1.pdf> (accessed September 6, 2006).

determination as to whether this particular OFT program conforms to the transformation goals and objectives, enough to warrant additional resources.

Using information taken from SME's from the Naval Surface Warfare community and from the OFT, this proof of concept will use the KVA approach for this analysis. The KVA will provide the framework necessary to depict the output of sub-process assets as common units of measure. The market comparables can then be derived from the assessment of equivalent private industry core processes. This will allow the comparative revenue estimates to be made for the process outputs of DoD service program operations, which are non-profit oriented. KVA methodology provides estimates allowing a revenue generated baseline construct to be developed for the cost of operational sub-processes. This now provides the data needed for cost and value assessments, such as ROI.

1. Objective

The overall objective of this research was to develop a model and methodology to assist in the evaluation and value assessment of the DoD OFT's Wolf PAC Stiletto operations. For the purposes of the thesis the focus of the model will be the evaluation of the Stiletto operational mine hunting capability. Of the Stiletto's many projected operational capabilities, the mine hunting exercises were the first and most recently tested for the vessel during the period of 08 May 2006 - 12 May of 2006. Once value metrics were defined and a baseline created for existing mine hunting capabilities and future operational capabilities, comparisons could be made and the impact

accessed. Results could be utilized to make judgments related to further investment into R&D and also, procurement.

2. Methodology

This proof of concept obtained information from SMEs from the surface warfare community through interviews and conversations to be used as the "As-Is" process information. The extracted sub-process input will be analyzed to reflect a cost for those sub-processes using the KVA method and value estimates. This analysis establishes the "As-Is" baseline for the model. Application of the KVA methodology will be used to analyze whether the Stiletto ship, will enhance the mine hunting operational capabilities through the use of its advanced IT assets. Resulting ROK value and cost estimates will reflect the impact the introduction of IT has on the operational process. Additionally, analysis can be conducted through comparison between the "As-Is" and "To-Be" models to make determinations regarding ROI.

3. Defining the Mine-Hunting Process

The United States Navy conducts mine hunting operations with Coastal Mine Hunter (MHC) ship. MHC has a crew size of 55 personnel. However, not all crew members are directly involved with mine operations when they take place. For the purpose of this thesis, only the billets that have a direct impact on the mine hunting are identified.

a. Operations Officer (OPSO)

The Operations Officer (OPSO) has the overall responsibility for the conducting the strategic and

tactical mine hunting operation missions. Additional duties accomplished by the OPSO outside of mine hunting operational duties are not applicable to this thesis.

b. Damage Control Assistant (DCA)

The Damage Controlmen perform the work necessary for damage control, ship stability, firefighting and fire prevention. They also repair damage control equipment and systems. Additional duties that may be accomplished by the OPSO outside of mine hunting operational duties are not applicable to this thesis.

c. Minemen Chief/Combat Information Center (CIC) Officer

The Minemen chief has the overall responsibility as the senior Minemen of the operational performance of all Minemen. He has the additional collateral duty during mine hunting operations as the CIC officer. He will function in the mine hunting tactical nerve center, the CIC, of the ship as part of the C2 team. Additional duties that maybe accomplished by the OPSO outside of mine hunting operational duties are not applicable to this thesis

d. Minemen

Minemen have the responsibility aboard the MHC of assisting in the detection and neutralization of underwater mines. They handle and operate deck-loaded mine neutralization equipment, performing electrical and electronic checks and tests of circuitry and components. Additional duties that maybe accomplished by the Minemen outside of mine hunting operational duties are not applicable to this thesis.

4. Assumptions

The following assumptions as they apply to the conceptual c2 model, KVA proof of concept.

a. Cost Assumptions

Cost of active duty military personnel was derived from annual DoD military personnel salary for Fiscal Year 2006 as presented on the Defense Finance and Accounting Service.³⁴

MHC total costs per hour based on yearly salaries		
Personnel	Rank	Yearly Salaries
1	O-4	\$70,000.00
2	O-3	\$110,000.00
2	O-2	\$90,000.00
1	E-7	\$40,200.00
2	E-6	\$68,000.00
3	E-5	\$84,000.00
5	E-4	\$120,000.00
11	E-3	\$220,000.00
27		\$802,200.00
Average cost per hour		\$11.43

Table 10. MHC Total Costs Per Hour

b. Market Comparable Revenue Assumptions

Similar to the Part I model, surrogate revenues in this scenario are based on a market comparable approach. For this model, the market comparables were derived by obtaining average costs of commercial shipping operations similar to that of the Coastal Mine Hunter. Since there are no for profit commercial ships that conduct mine

³⁴ Defense finance and Accounting Service. "Basic Pay" <http://www.dod.mil/dfas/militarypay/newinformation/WebPayTableVersion2006updated.pdf> [01 January 2006] (accessed August 22, 2006).

hunting operations, a direct comparison to the MHC could not be made. However, there are commercial ships that specifically operate in coastal waters. For this model we used dredging ships to determine a market comparable per job price. We were able to calculate a per job price by averaging the cost of dredging jobs from several different dredging corporations. We then used this calculated amount in the same manner as that of the Part I model.

5. Defined Mine-Hunting Sub-Processes

Unlike the previous C2 model in Part I, the sub-process for the mine hunting operations are not necessarily sequential. However, they are conducted at some point in the completion of operational mission. Some sub-processes happen concurrently, respective to one another. For the "As-Is" process to be a viable source for use with KVA methodology, the sub-processes were derived from descriptions given by SME's in the MHC ship community. Understanding the current "As-Is" sub-process is important to be able to understand how IT and or re-engineering the process might possibly create a more desirable process. Mine hunting sub-processes shown below in Table 10.

Process Billets	Sub-process
OPERATIONS OFFICER	Interpreting Intel Reports Writes Action Messages Plans Operational Actions Mine Brief Maneuver ship course
DAMAGE CONTROL ASSISTANT	Firefighting Team Operations External Safety Operations
MINEMEN CHIEF/COMBAT INFO OFFICER	Checking Communication in Combat Information Center Comparing charts between CIC and Bridge Provide safety for operations
MINEMEN	Mine Neutralization Vehicle Operation Maintenance Deployment/Redeployment Checking Communication between the bridge and fantail of the ship

Table 11. Mine Hunting Sub-Processes.

The sub-processes listed and their associated functions are necessary to conduct a mine hunting operation. However, depending on operational circumstances some of the sub-processes might not be conducted in every mine hunting operation. For the purposes of this model it will be assumed all the sub-processes will be conducted at some point during the operation. Further clarification of each sub-process is given is provided below as provided by the SME of the MHC community.

a. Interpreting Intelligence Reports

The OPSO deciphers all intelligence reports which provide situational awareness for the current mission. It is imperative that the OPSO handles acceptance and response of mission intelligence reports in a timely manner.

Intelligence reports which may be time sensitive are essential information in the assessment and planning for the mine-hunting operations.

b. Writes Actions Messages

The OPSO develops and communicates all ship action messages to higher authorities within the chain of command. Action messages report all ships planned activity to be implemented during current operation. Action messages are also developed to report actual activity that has occurred during the operation. Also actions messages are developed to report results of the operation after mission is completed.

c. Plans Operational Actions

The OPSO develops operational courses of actions for the mine hunting mission for the Commanding Officer decision. Course of action developments are based on the Commanding Officer's Intent and current situational awareness (i.e., intelligence reports, current area of operations).

d. Mine Brief

The OPSO develops a mine brief for the operational mission. The mine brief is developed and disseminated to those personnel who are directly involved in the mine hunting operation. The mine brief should present a clear common picture of the operational missions, functions, and tasks to be accomplished during the operation. The mine brief includes detailed analysis of area of operations for the mission.

e. Maneuver Ship's Course

The OPSO charts and maneuvers the ship's direction and course during the operational mission, within the area of operations.

f. Firefighting Team Operations

The Damage Control personnel do the work necessary for damage control, ship stability, fire fighting and prevention that may occur in actions associated with mine hunting operations.

g. External Safety Operations

The Damage Control personnel perform the external safety operation of ensuring mines are pushed away from the ship which are discovered and are too close to ship's proximity to destroy.

h. Checking Communication in Combat Information Center (CIC)

The Minemen chief performs the collateral duty of the CIC officer during mine hunting operations. He will evaluate, disseminate, and process all information that is received within the ships tactical CIC during mine hunting operations.

i. Chart Comparison between the CIC and the Bridge

The Minemen chief monitors, tracks and charts the ships planned versus actual maneuvered course relative to its area of operations. He reports all discrepancies to the OPSO

j. Provide for Safety Operations

The Minemen chief oversees the safety operations which involve back aft equipment deployment and redeployment, specifically, the operations involving the Mine Neutralization Vehicle and equipment.

k. Mine Neutralization Vehicle (MNV) Operation

Minemen perform all tasks associated with the operation and maneuver of the MNV during mine hunting operations.

1. Maintenance

Minemen perform tasks associated with maintenance of the MNV and associated equipment (i.e., performing electrical and electronic checks and tests of circuitry and components of the MNV).

m. Deployment and Redeployment

Minemen perform tasks associated with the handling the deployment and redeployment of the deck loaded MMV for the mine hunting operations.

n. Checking Communication between the Bridge and Fantail of the Ship

Minemen must ensure constant communication is maintained between bride and fantail of the ship. Updated reports of fantail operations are reported to the CIC and OPSO.

6. "As Is" KVA Analysis

An analysis of each sub-process within mine hunting operation of the MHC ship is provided in the Table 11. The core processes listed have been defined by the SME in the surface warfare community who served tour of duty aboard a MHC class ship. Each category for the KVA analysis is defined below.

a. Ordinal Ranking

The "ordinal rank" of the sub-processes was assigned by the SME who ranked the sub-processes based on complexity. Lower numbers equate to less complexity while larger numbers depict more complexity. The complexity of the processes is also indicated by the actual learning time (ALT) column where the most complex tasks are presumed to take longer to learn. This ranking is completed independently of ALT estimates. In order to demonstrate the reliability of the ranking estimates, a correlation is

derived mathematically between ordinal ranking and ALT. A high correlation percentage between these columns is an indication that the estimates are accurate when compared to the complexity of the sub-processes and the time it takes to learn them (ALT).

b. Learning Time

"Learning time" is considered the knowledge embedded in a process. It is also considered proportionate to the amount of knowledge learned. The learning time category is derived using a common individual as the baseline reference point. Therefore, the SME was instructed to provide the estimated time to learn the sub-process based on the time it would take an average person to learn the given process. Examples of process learning for this category include formal schools and distance education among others.

c. On-the-Job Training

"On-the-Job Training (OJT)" is considered an additional part of process learning. It is considered in the determination of the alternate learning time. Examples of OJT include training ship on-board ship, manuals, and other informal instruction.

d. Alternate Learning Time

This category is the total amount of learning for the total sub-process. It is the result of learning time plus On-the-Training.

e. Percentage of IT

This is a representation of the extent to which automation is utilized in the sub-process. IT is measured on a scale from zero percent to 100 percent. Estimating the IT involvement accurately ensures that knowledge which is embedded in the IT resources is accounted for within the

sub-process. Also the IT column identifies how information technology is used to complete the process, hardware and software IT designed and implemented for the purposes of enabling the mine-hunting sub-processes. The degree of automation in the sub-process is considered the amount of activity that is completed by IT resources.

f. Total Learning Time

Total Learning Time represents the amount of knowledge embedded in the sub-process. It is determined by multiplying the number of personnel involved in the sub-process, the number iterations of the sub-process, and the SLT. This result is divided by the percentage of IT category, (1-IT%). The calculation total is the amount of sub-process output, by knowledge asset, used in the execution of this process.

g. Times Fired

Times fired category represents the number of times each sub-process is executed by the specified ship personnel. In this process the specific sub-process may have multiple occurrences at different points within the overall process. Determination of times fired is an estimate from the SME based on his knowledge and experience of the actions that are required and taken during a mine-hunting operation.

h. "Number of Persons"

The "Number of Persons" category represents the number of personnel which are involved in the specific sub-process. Personnel are assigned to performing duties of the sub-process. The number of participating personnel in a sub-process is based upon SME estimates, noting there is no standard.

i. Total Knowledge (K)

Total knowledge represents the amount of knowledge embedded in the sub-process. It is determined by multiplying the number of personnel involved in the sub-process, the number of times fired for the particular sub-process, and the SLT. This result is divided by the percentage of IT category, (1-IT%).

j. Numerator

The numerator category represents the revenue amount allocated based on the percentage of the amount of knowledge embedded in each stage in terms of total knowledge. "It can be represented as a percentage of the revenue or sales dollar allocated to the amount of knowledge required to obtain the outputs of a given process in proportion to the total amount of knowledge required to generate the corporation's salable outputs."³⁵ The numerator was calculated by multiplying the average fee of the market comparable business (hourly rate \$54.56) by the number of their personnel (20) and by the number of hours to complete all sub-process. The numerator is derived by multiplying the learning time allocation factor % by the total revenue for each sub-process.

k. Denominator

The denominator represents the costs that are used to generate the outputs or expenses of the process. The cost in this case, or denominator, is derived from the time it takes to complete a sub-process task multiplied by the number of people involved per the sub-process multiplied by the average cost per hour for completing the

³⁵ Housel and Bell, p. 40.

work. Military base pay for selected pay grade across staff section was used in order to compute the average cost per hour for this analysis.

1. *Return-On-Knowledge*

Return on Knowledge (ROK) is the ratio between the pseudo revenue numerator and the total cost denominator. This ratio allows for comparison of expenses and revenues associated with the embedded knowledge assets. This ROK will be used to compare efficiency in performance within a sub-process and assist in determination of relative value.

m. *"As-Is" Data Analysis*

The format shown in Table 12 displays the core process subdivided into sub-processes in order to evaluate each sub-process and provide a method to examine its relative value. This was done by placing the focus on the determination on the ROK ratios that were produced. The "As-Is" analysis provides a measure of the productivity of the knowledge assets within the process.

Process Billets	Subprocess	Rank Order	LT (hrs)	OUT (hrs)	ALT (hrs)	%LT	TLT (hrs)	Time to Complete (hrs)	Times Fired	# of persons	(N) = TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue/Expense)
OPERATIONS OFFICER	Interpreting Intel Report	4	3	40	43	20.0%	53.75	2	1	1	53.75	0.38%	\$85.17	\$22.86	37%
	Writes Action Messages	2	1	2	3	10.0%	3.33	1	2	1	6.67	0.05%	\$10.56	\$22.86	5%
	Plans Operational Actions	11	3	1040	1043	10.0%	1158.89	3	1	1	1158.89	8.21%	\$1836.32	\$34.29	536%
	Mine Brief	8	1	2	3	10.0%	3.33	0.5	1	1	3.33	0.02%	\$5.28	\$5.72	9%
	Maneuver ship course	12	0	520	520	0.0%	520.00	2	1	1	520.00	3.68%	\$823.97	\$22.86	360%
DAMAGE CONTROL ASSISTANT	Firefighting Team Operations	7	40	520	560	0.0%	560.00	1.5	1	10	5600.00	39.67%	\$8873.51	\$171.45	518%
	External Safety Operations	6	0	320	320	0.0%	320.00	1	1	3	960.00	6.80%	\$1521.17	\$34.29	444%
MINEMAN CHIEF/COMBAT INFO OFFICER	Checking Communication in Combat Information Center	5	1	320	321	0.0%	321.00	0.5	1	2	642.00	4.55%	\$1017.28	\$11.43	890%
	Chart Comparison between CIC and Bridge	10	40	0	40	0.0%	40.00	0.5	1	2	80.00	0.57%	\$126.76	\$11.43	111%
	Provide safety for operations	9	40	320	360	0.0%	360.00	2	1	2	720.00	5.10%	\$1140.88	\$45.72	250%
MINEMAN	Mine Neutralization Vehicle Operation	14	240	1040	1280	0.0%	1280.00	3	1	2	2560.00	18.13%	\$4056.46	\$68.58	591%
	Maintenance	13	240	520	760	10.0%	844.44	2	1	2	1688.89	11.96%	\$2676.14	\$45.72	585%
	Deployment/Redeployment	3	0	10	10	0.0%	10.00	1	2	6	120.00	0.85%	\$190.15	\$137.16	14%
	Checking Communication between the bridge and tactical of the ship	1	0	2	2	0.0%	2.00	0.5	1	2	4.00	0.03%	\$6.34	\$11.43	6%
					5265		5476.75	20.50			14117.53	100.00%	\$22,370.00	\$645.80	346%

Table 12. As-Is.

The resulting "As-Is" analysis provides the ability to access current state of mine hunting operational sub-processes to future or "To-Be" sub-processes of the Stiletto ship. Comparisons made of the two scenarios assists in determining if programs/projects with innovative IT concepts are viable solutions for the improvement and are worthy of further research and investment.

7. "To-Be" KVA Analysis

The "To-Be" analysis is a representation of the future sub-processes of mine hunting operations, which reflect the capabilities of the new Stiletto ship. Demonstrated in the "To-Be" representation of sub-processes is a reengineered process which is affected by the increased utilization of the IT assets and automation. Not all sub-processes will be affected in this "To-Be" analysis. Comparisons will only be made for those sub-processes that were modified. Remaining sub-process will remain unchanged.

a. Reengineered Process

The major change from the "As-Is" process to the "To-Be" process is the introduction of the Electronic Keel technology. "Stiletto", employs an "electronic keel" that combines the processing power of a bank of supercomputers with the networking capability coupled to a robust onboard communications system that facilitates data-sharing with other nodes on internal and external networks."³⁶ Ultimately, what this technology provides is the ability to continue mission planning as the current operation takes place because of the immediacy of the information feedback. The robust network capability improves the C2 capability of the decision makers at the Stiletto ship level and higher levels, by its ability to provide real time information.

³⁶ Department of Defense, Office of Force Transformation, Wolf PAC. <www.oft.osd.mil/initiatives/stiletto/TransformationDefense>. (accessed 01 August 2006).

This assists in the elimination of human errors due to translation of information. It also provides increased response time by eliminating human feedback and reporting function. In order to account for this added IT knowledge increase, the IT percentage output will be reflected in several sub-processes and the elimination of personnel required to perform certain sub-processes will be identified.

The other major change to the "To-Be process is the Unmanned Underwater Vehicle (UUV) which the Stiletto ship uses for mine-hunting vice the MMV which the MHC ship uses in its mine-hunting operation. The UUV technology is not only used to hunt the mines but it also has the ability to locate and map the mine field and report back the real time information to the Stiletto ship in concert with the ships electronic keel. This has great potential to positively affect C2, because the IT technology will allow for the earlier synthesis, initial planning and follow-on planning at increased rates.

Table 13 depicts the KVA estimates used to determine the total ROK for the representative "To-Be" model, the Stiletto ship. Changes that have been made from the "As-Is" model are shown in a shaded corresponding cell box. Elimination of any sub-processes due to the overall re-engineered process is shown with a shaded area through the entire sub-process row.

Process Billets	Subprocess	Rank Order	LT (hrs)	OUT (hrs)	ALT (hrs)	%IT	TLT (hrs)	Time to Complete (hrs)	Times Fired	# of persons	Total Knowledge (K) = TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue/Expense)
OPERATIONS OFFICER	Interpreting Intel Report	4	3	40	43	50.0%	86.00	2	1	1	86.00	0.49%	\$103.56	\$22.86	45%
	Writes Action Messages	0	0	0	0	0.0%	0.00	0	0	1	0.00	0.00%	\$0.00	\$0.00	0%
	Plans Operational Actions	11	3	1040	1043	50.0%	2086.00	3	1	1	2086.00	11.81%	\$2,512.00	\$34.29	73%
	Mine Brief	8	1	2	3	10.0%	3.33	0.5	1	1	3.33	0.02%	\$4.01	\$5.72	7%
	Maneuver ship course	12	0	520	520	0.0%	520.00	2	1	1	520.00	2.94%	\$626.19	\$22.86	274%
DAMAGE CONTROL ASSISTANT	Flieflighting Team Operations	7	40	520	560	0.0%	560.00	1.5	1	2	1120.00	6.34%	\$1,348.72	\$34.29	389%
	External Safety Operations	6	0	320	320	0.0%	320.00	1	1	2	640.00	3.62%	\$770.70	\$22.86	337%
	Checking Communication in Combat Information Center	5	1	320	321	50.0%	642.00	0.5	1	1	642.00	3.63%	\$773.11	\$5.72	1353%
CIC	Comparing charts between C/C and Bridge	10	40	0	40	75.0%	160.00	0.5	1	1	160.00	0.91%	\$192.67	\$5.72	337%
	Provide safety for operations	9	40	320	360	0.0%	360.00	2	1	1	360.00	2.04%	\$433.52	\$22.86	190%
	UUV	14	240	1040	1280	75.0%	5120.00	3	1	2	10240.00	57.95%	\$12,331.18	\$68.58	1798%
Seal Team	Maintenance	13	240	520	760	10.0%	844.44	2	1	2	1688.89	9.56%	\$2,033.79	\$45.72	445%
	Deployment/Redeployment	3	0	10	10	0.0%	10.00	1	2	6	120.00	0.68%	\$144.51	\$137.16	11%
	Checking Communication between the bridge and tailail of the ship	1	0	2	2	0.0%	2.00	0.5	1	2	4.00	0.02%	\$4.82	\$11.43	4%
		5262	10713.778	19.50	17670.22	100.00%	\$21,278.78	\$440.06	484%						

Table 13. To-Be.

The automation of the sub-processes had the greatest effect on ROK. With the increase in IT in the Stiletto ship, sub-processes assigned to the Operations Officer were positively affected. The "interpreting intelligence reports" and the "plans operational actions" IT percentage were both increased to 50 percent and 60 percent respectively. The use of the electronic keel and the capability of the UUV allows for the increased IT percentages in these sub-processes. The "writes action messages" sub-process is eliminated due the networking and communication integration capability of the electronic keel. It also has the ability to produce real-time situational awareness for higher, lower, and adjacent echelon commands involved in the operation.

"CIC communication" and "Chart Comparison" are now aided even more. The UUV technology aids in the plotting and charting of mines, therefore justifying the increase in the IT percentage. Also the requirement for the "number of personnel" to perform these particular sub-processes has been reduced. This is due to the increased IT percent usage and the limitation of the ship crew size requirement of the Stiletto. This decrease in personnel also results in a decrease in the costs of the specified sub-processes. Additionally, the sub-processes in which the size of personnel needed was reduced were those that had duties associated with the Damage Control Assessment team billets.

Another change to the core process in this model is the Minemen, which the Stiletto does not have; sub-process actions are similarly replaced by the operational

Seal Teams who provide all operational support the UUV. The UUV added technological capabilities, is represented as an increase in the IT percentage for the sub-process.

8. Comparative Analysis and ROK

The comparative analysis Table 13 gives a side-by-side comparison of the ROK percentage. The information displayed in bold gives the changes in ROK percentage for those sub-processes which were altered in order to represent Stiletto operational sub-processes. The addition of Stiletto IT automation, introduced into the respective sub-process, had major impacts on the mine hunting operation analysis.

Comparative Analysis

Sub-processes	As IS ROK (Revenue/Expense)	To BE ROK (Revenue/Expense)
Interpreting Intel Report	37%	45%
Writes Action Messages	5%	0%
Plans Operational Actions	536%	733%
Mine Brief	9%	7%
Maneuver ship course	360%	274%
Firefighting Team Operations	518%	393%
External Safety Operations	444%	337%
Checking Communication	890%	1353%

Sub-processes	As IS ROK (Revenue/Expense)	To BE ROK (Revenue/Expense)
in Combat Information Center		
Chart Comparison between CIC and Bridge	111%	337%
Provide safety for operations	250%	190%
Mine Neutralization Vehicle Operation/UUV	591%	1798%
Maintenance	585%	445%
Deployment/ Redeployment	14%	11%
Checking Communication between the bridge and fantail of the ship	6%	4%
TOTAL	346%	484%

Table 14. Comparative Analysis.

ROK displayed for both the "As-Is" and "To-Be" shows the knowledge assets that are embedded in these represented scenarios. The ROK results indicated that there will be significant value that can be found in both ship's mine hunting operations sub-processes, which can be similarly evaluated and assessed. The knowledge-value ROK total increase for the re-engineered process of the Stiletto ship

operations is depicted in Table 13. Overall, total ROK value is significantly greater for the "To-Be" process. However, it is noted in this model that even though the total ROK value for the "To-Be" process increased over that of the "As-Is" process, not all sub-processes increased respectively. The major factor contributing to these decreases can be attributed to the reduction in personnel manning allowed for by the Stiletto. Personnel are considered part of the knowledge assets within a sub-process. With a reduction in the Stiletto ship board personnel billets, this ultimately decreases the knowledge the assets within the sub-process.

This model demonstrates the Stiletto capabilities have great potential in increasing operational value with respect to the Navy's current mine hunting operations.

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V. CONCLUSIONS AND RECOMMENDATIONS

With the DoD acquisition of programs and projects becoming increasingly expensive, it is important that the method or measure for determining value for a particular project, real or conceptual, be identified and used enterprise-wide. Shrinking DoD budgets prompt a move away from investing in programs simply because they represent the "new technology" of the day. Instead the DoD should rely on trusted evaluation methods and techniques to value its programs and projects. The KVA methodology shows promise to be one such tested methodology based on its use by hundreds of companies in which the resulting outcomes led many to revisit the way they view and run their corporations.

The possible uses of Knowledge Value Added (KVA) as a methodology to evaluate the OFT Wolf-PAC / Stiletto program concepts and surrogates programs is promising. It shows promise because of the potential of this methodology to be used throughout the DoD to make relevant and measurable evaluations of other DoD projects and programs that were formerly improperly evaluated or not evaluated at all. Using the KVA methodology for assessment of the OFT's Wolf PAC program, this thesis explored two distinctly different areas to demonstrate KVA's use and benefit. This thesis approached the following subject under the Wolf PAC purview: Part (1) used the KVA method to find the improvements in a notional C2 process and Part (2) showed the increase value of the Stiletto ship in littoral operations, more specifically mine hunting. As in the

private sector where the use of KVA generated the outcomes which in turn led to the revisiting of corporate methodologies, KVA promises similar rewards for DoD.

This thesis displayed the operational value in both proof of concept scenarios. Value determination in the form of ROK provided informative insight to operational processes of both scenarios. The proof of concept scenario in Part I showed the ability of KVA to be used with a conceptual program model. The evaluation of the C2 conceptual program model demonstrated that with the meaningful metrics the KVA method provided, relevant measures of effectiveness. As a result value could be determined. These research findings are consistent with other studies done the on the application of this methodology.

No measurement methodology, however useful, can replace the creative insights, judgment and intuition of managers and investors. KVA is no exception to this rule and is best used as a decision support tool.³⁷

Based on an acceptance of the above statement, it should be the goal of an organization to disseminate the KVA methodology in order to "establish a common framework within the DoD for understanding, evaluating, and in the end justifying the impact of government investments"³⁸ into existing as well future projects and programs.

A. RECOMMENDATIONS TO THE NAVY

With the rapid changes in technology and with such a vision and emphasis of a total networked military force, it

³⁷ T. Housel and A. Bell, *Measuring and Managing Knowledge*. Boston: McGraw_Hill, 2001. p. 106.

³⁸ Rios, Cesaer, ROI Analysis of Information Warfare System. Naval Postgraduate School, Monterey, CA, 2005. p. 46.

is necessary to continue the development of the Wolf-PAC/Stiletto concept. It would greatly benefit the Navy to fully exploit the technology that this vessel could offer to the fleet. The full capabilities of this craft have yet to be exploited. The KVA analysis has shown a noticeable increase in the ROK percentage to the overall process designed from the C2 as well as an increasing overall process in the mine hunting operations of the Stiletto.

This craft embodies several capabilities:

- The ability to adapt to different mission areas and the capability to tailor its payload based on the assigned task.
- An improvement in performance and greater cargo space based on the lighter nature of carbon-fiber construction than of a steel equivalent.
- New hull form leaves no bow wake. It "eats" or consumes its own wake, and combined with the hydrodynamic lift, this allows it to cushion itself at high speeds.³⁹
- A fully networked combat electronics suite which allows the process of information in a more rapid matter.

It was the goal of this research to provide the means to measure value through the use of the Housel/Kanevsky KVA methodology and to explore a potentially suitable methodology to reflect the ROI return on investment within some DoD programs and projects. The KVA methodology is a proven analytical tool that can provide insight and assess value into areas or processes of a project/program that may not have been previously explored within an organization. The findings of this research should be helpful in the austere funding environments the DoD potentially faces in

³⁹ Stiletto Cuts a Swath to New Navy Technologies, Robert K. Ackerman March 2006. <<http://www.afcea.org/signal/articles/anviewer.asp>> accessed August 30, 2006).

the future, when it will be necessary to ensure that tested measurable approaches are utilized in the determination of the ROI of programs within the DoD.

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